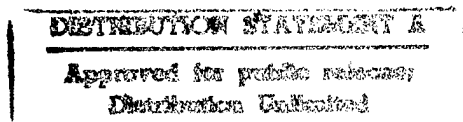# The Fox Project: Advanced Development of Systems Software

R&D Status Report
July 1 to September 30, 1997

School of Computer Science
Carnegie Mellon University
Pittsburgh, PA 15213

19971021 039

The long-term objectives of the Carnegie Mellon Fox Project are to improve the design and construction of systems software and to further the development of advanced programming language technology. We use principles and techniques from the mathematical foundations of programming languages, including semantics, type theory, and logic, to design and implement systems software, including operating systems, network protocols, and distributed systems. Much of the implementation work is conducted in the Standard ML (SML) language, a modern functional programming language that provides polymorphism, first-class functions, exception handling, garbage collection, a parameterized module system, static typing, and a formal semantics. This Project involves several faculty members and spans a wide range of research areas, from (1) experimental development of systems software to (2) advanced compiler development to (3) language design.

1   Research Progress

For each of the three areas listed above, we report on the research accomplishments during the third calendar quarter of 1997, and the research objectives for the fourth quarter of 1997.

1.1   Experimental Development of Systems Software

Accomplishments (July-September):

- Completed intermediate performance analysis of Foxnet ATM.

- Ported Foxnet ATM to the SML97 language and latest release of SML/NJ.

- Developed a GSMP interface for Foxnet ATM control and a SLIP device.

Objectives (October-December):

- Conduct the final performance analysis of the Foxnet ATM system.

- Using results of the performance analysis, complete the journal submission on Foxnet ATM.

1.2   Language Design

Accomplishments (July-September):

- Finished the main implementation of the typechecker and normalizer for the TIL Middle Intermediate Language (MIL).

Objectives (October-December):

- Write a paper on the implementation of the TIL middle end for submission to the TIC (Types in Compilation) workshop.
- Reimplement the Elf proof-development system.

- Conduct an empirical evaluation of the representation of proof terms for proof-carrying code, using explicit substitutions.

- Complete the port of proof-carrying code to the Intel x86 architecture.

Noteworthy publications:

- Relational Interpretations of Recursive Types in an Operational Setting by Lars Birkedal and Robert Harper, Theoretical Aspects of Computer Science, September, 1997. Supported in part by Fox and in part by NSF.

- An Interpretation of Standard ML in Type Theory by Robert Harper and Christopher A. Stone. Tech Report CMU-CS-97-146. Also appears as Fox Memorandum CMU-CS-FOX-97-01.

1.3　SML Compiler and System Development

Accomplishments (July-September):

- Completed initial implementation of the TIL compiler, and used it to compile substantial programs.

- Adopted the MLRISC back-end from the SML/NJ system to work with the TIL compiler.

- Completed further debugging of the TILT elaborator, phase-splitter, and type-checker. Completion of a rudimentary separate compilation system for TILT. Preliminary compilation of most of the SML basis complete.

- Implemented a prototype certifying compiler and theorem prover, for a "Safe-C" subset of Java.

Objectives (October-December):

- Complete the second prototype TILT compiler for full Standard ML without optimization phases.

- Implement the most important of the additional optimizations with the MLRISC back-end with TIL compiler.

- Stabilize TILT and complete the rudimentary optimizations that will enable bootstrapping.

- Complete and submit research papers reporting the progress on certifying compiler and theorem prover.

2   Capital Equipment Purchases

- None.

3   Key Personnel Changes

- Edo Biagioni has left the Fox Project, to take a position as Assistant Professor at the University of Hawaii.

4   Noteworthy Meetings

- DARPA Quorum PI Meeting (Washington, DC, July 13-15) attended by Frank Pfenning.

- DARPA OS Security Workshop (Washington, DC, July 16-17). George Necula attended and presented Proof-Carrying Code technique.

- Workshop on High-Confidence Systems, Institute for Defense Analysis (Washington, DC, August 6-7). Peter Lee attended and presented the Proof-Carrying Code technique.

- DIMACS Workshop on Security and Cryptography (Rutgers, NJ, August 14-15). Peter Lee attended and chaired a session on "Programming Language Technology for Secure Mobile Code".

- CMU, September 16-25. Bryan Ford from University of Utah visited the Fox Project to investigate incorporation of PCC into the Utah OSkit.

5   Administrative Data

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